EXECUTIVE SUMMARY

1 Basics of the DATAMINE Project

The Root Idea:
Take advantage from large scale EP Certificate data collection in Europe

The starting point of DATAMINE was the fact that the current state of the European building stock and the on-going retrofit processes are not very well known. This information gap can be seen as a great obstacle for taking well-tailored measures to reduce the buildings' energy consumption.

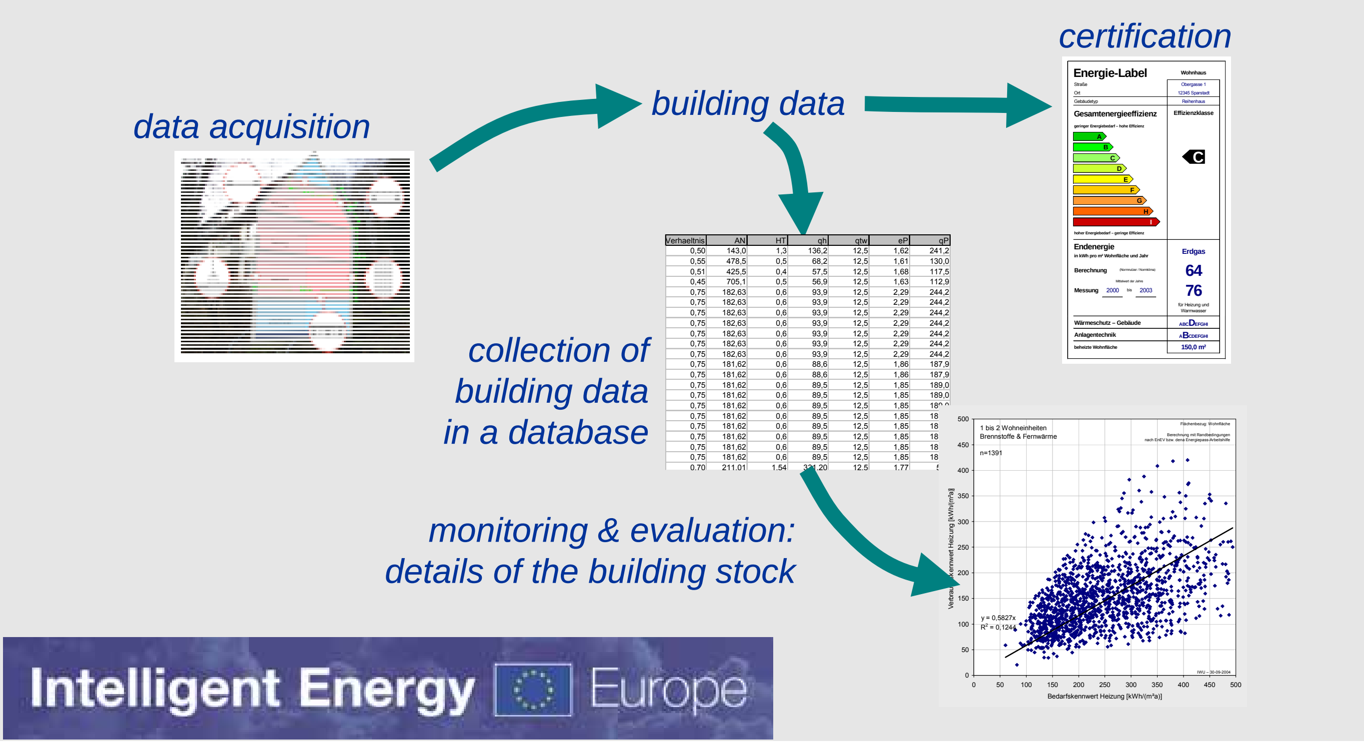
The idea of DATAMINE is to use Energy Performance (EP) Certificates as a data source for monitoring purposes. Given the great variety of buildings as well as certificate types in Europe and the very different status of national EPBD[1] implementation efforts, a general monitoring system can only be implemented in the long run. Thus the objective of DATAMINE is to make basic experiences in data collection and analysis on a practical level and to draw conclusions for establishing harmonised monitoring systems.

[1] Energy Performance of Buildings Directive

A Bottom-Up Approach:
Make basic experiences in Model Projects

For this purpose Model Projects were carried out in 12 EU member states. In each Model Project data collection and monitoring using EP Certificates or energy audits were tested on a small scale. Each Model Project has an individual design, addressing different building utilisations and certification types, as well as data collection methods and monitoring targets – depending on the focus of the involved key actors. Accordingly, each Model Project considers different national certification or data collection activities.

This means that DATAMINE is a bottom-up project: There was no standardised monitoring approach to be realised during the 12 Model Projects - quite the opposite: Each model project had its own aims, data sources and solution approaches reflecting a large variety of monitoring problems. The idea of DATAMINE is to first learn from the execution of these different Model Projects, and then to generate ideas for other, maybe similar monitoring activities in the future.



The Benefits of a Common Language: Compare Data from Different Countries by use of a Harmonised Data Structure

Given that the 12 projects were simultaneously carried out in 12 EU countries raised an issue of whether there is a way for a common analysis of the collected data or at least for a common understanding of the data from different projects. To handle this issue a harmonised data structure with 255 data fields was defined. The "philosophy" of this approach was as follows: Each project partner could use his own data structure (for example specified by the applied software) and carry out his analysis on an individual basis according to the objectives and conditions of the individual Model Project. At the end the national data base was translated to the harmonised data structure that was then delivered to the project coordinator IWU who collected all data in a common evaluation data base. This made possible a comprehensive analysis during which a number of energy performance indicators from different countries could be compared. Since the harmonisation of definitions enabled each partner to gain an easy understanding of the data from other countries, the DATAMINE Data Structure can be seen as a simplified "common language" that facilitates an understanding of data bases from different projects.

The Conclusions: How to Extend Energy Performance Monitoring Activities in the European Building Sector

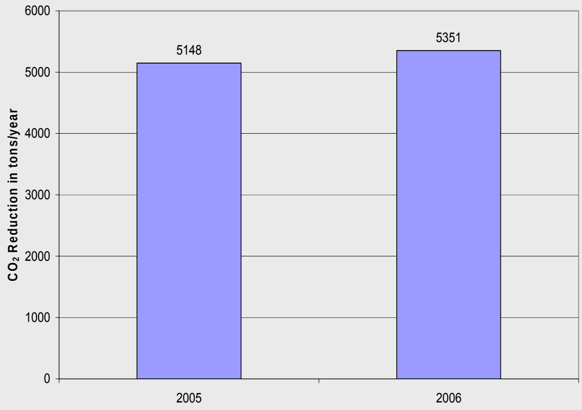
The DATAMINE project partners also draw general conclusions concerning monitoring with the help of energy certificates. Based on the experiences with data collection during the Model Projects and with cross-country comparison, concrete recommendations are given for future steps. The problem of answering the basic questions about energy performance of the national building stocks is addressed as well as specific monitoring aims and the harmonisation and international comparability of the results.

2 Results from the Model Projects

Model Project 1: Germany (IWU)

The German project had a very specific aim: The carbon dioxide emission reduction of the measures which were supported by an energy saving support programme in the region of Hannover had to be estimated. There were good basic conditions for applying the DATAMINE approach because the issuing of an energy certificate was a prerequisite for getting support from the programme. So by analysing the data of more than 500 energy certificates (asset rating, reflecting the state of the buildings before modernisation) and the programme statistics (number and type of supported energy saving measures) the carbon dioxide emission reduction in 2005 and 2006 could be calculated. Apart from that a survey of the energy performance of the supported buildings before modernisation was given. A DATAMINE interface was developed and implemented in an energy certificate software tool which is very common in Hanover.

Fig. 1: Exemplary result from Model Project 1

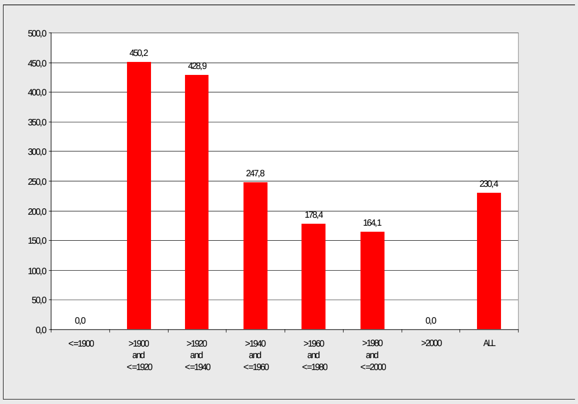


Saving of carbon dioxide emissions by the measures which were funded in the proKlima-Altbau programme in 2005 and 2006

Model Project 2: Poland (NAPE)

In the Polish project a sample of 130 energy audits (mainly asset rating) was used to get an overview of the energy properties of residential buildings in Poland. Inter alia the U-values of walls, roofs, windows and basement areas were examined in relation to the construction period of the buildings. The analysis was concentrated on large buildings with a living space of more than 1000 m².

Fig. 2: Exemplary result from Model Project 2

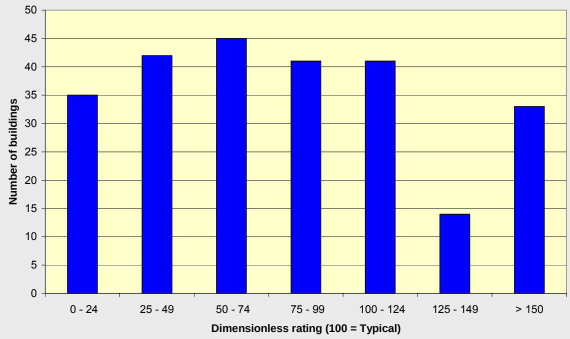


Average calculated energy consumption per m²

Model Project 3: UK (ESD)

The project was dealing with operational rating of different types of non-residential buildings. The building data were collected by an existing internet tool (EPLabel) and transferred to the DATAMINE data structure by a new software application. EPLabel is working on international level, so that building data from different countries can be collected. Circa 300 data sets were available, the analysis was concentrated on buildings from UK, for the most part office buildings.

Fig. 3: Exemplary result from Model Project 3

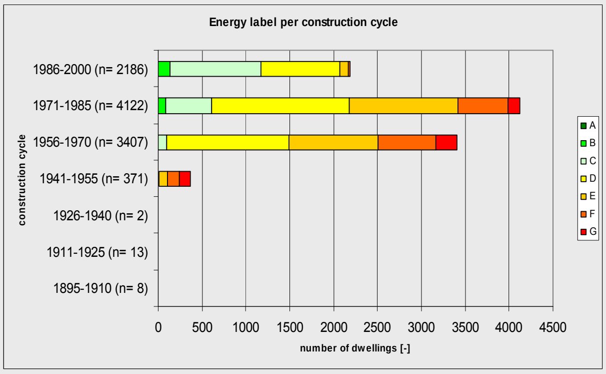


Operational performance of the 251 buildings in the UK datasets (100 = Typical, < 100 is better than Typical, > 100 is worse than Typical)

Model Project 4: Netherlands (BuildDesk)

The main aim of the Dutch project was to improve the portfolio management of two big housing companies in Tilburg. The data bases included altogether more than 10.000 data sets (mostly apartments). Energy data were analysed in combination with cost data. Inter alia social aspects were considered: It was pointed out that especially low-rent apartments (usually inhabited by low-income renters) have a relatively high energy consumption and relatively high energy costs. The analysis also showed that a good overall energy performance may often be caused by energy-efficient district heating – but nevertheless the heat demand of the buildings and the heating costs may be considerably high.

Fig. 4: Exemplary result from Model Project 4

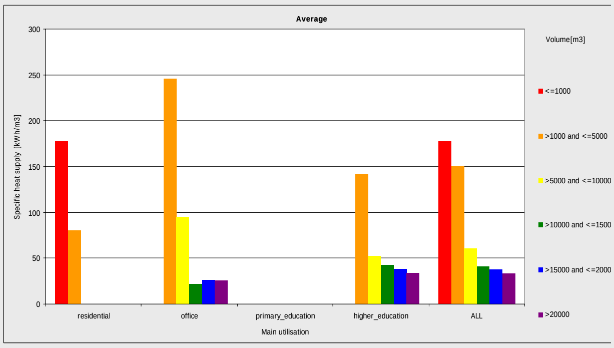


Average energy indices and energy labels related to building construction cycle

Model Project 5: Italy (POLITO)

Two different samples were analysed: Data from 138 buildings in the Province of Torino – most of them higher education schools – gave an overview of the energy consumption depending on the used energy carrier, the size of the buildings and the climate data (which may considerably differ within the province). A second sample of 50 asset and operational rating data sets from social multi-family buildings of a social housing company in the city of Torino did not only provide an overview of the energy performance of the buildings stock but was also used for a comparison of the measured and the calculated energy consumption as well as for a comparison of five different regional Italian energy balance calculation methods.

Fig. 5: Exemplary result from Model Project 5

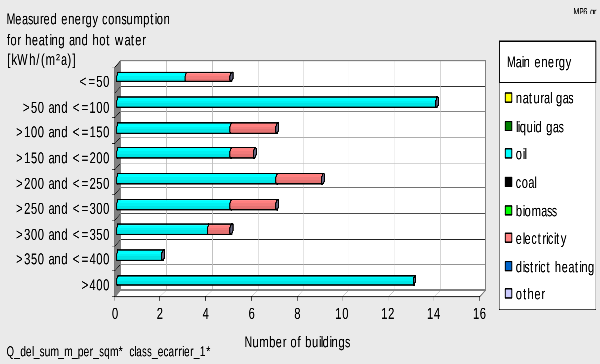


Distribution of the specific heat supply as a function of the main utilisation and of the volume

Model Project 6: Greece (NOA)

The Hellenic model project was based on a sample of 250 buildings from different regions in Greece available from pilot energy audits performed in the framework of European projects for the development of audit methodologies and software (40% of available data), and other short energy audit campaigns using standard questionnaires and energy audit reports (60% of available data). NOA performed data quality checks and implemented in the evaluation data base (EDB). In total, 70% of the available data are residential buildings, and the rest different end-uses of non-residential buildings (offices, hospitals, hotels, sports centers, airports, and schools). About 40% of the available data (72 buildings) were for asset rating, while for the remaining 178 buildings with operational rating there was often additional available data on energy performance and thermal envelope characteristics. A detailed analysis of the energy related building properties of the sample was carried out including the U-values of the different building elements, the different types of heat supply systems and the energy balance – including measured and calculated energy consumption.

Fig. 6: Exemplary result from Model Project 6

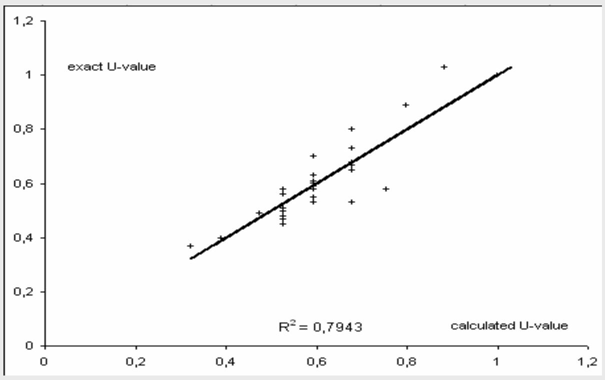


Frequency of measured energy ware consumption – tertiary sector (consumption summarized for all energy carriers, per m^2 reference area)

Model Project 7: Belgium (Vito)

The project made use of an auditing procedure for single family houses with official audits being uploaded to a central server of the Flemish Region. A number of 113 data sets were analysed (asset rating). The main target was the making of a “typology” of building elements in order to simplify energy auditing that means to save time and costs. For example a procedure for the estimation of the U-value of a wall depending on the type of the wall, the year of erection and the insulation layer thickness was developed.

Fig. 7: Exemplary result from Model Project 7



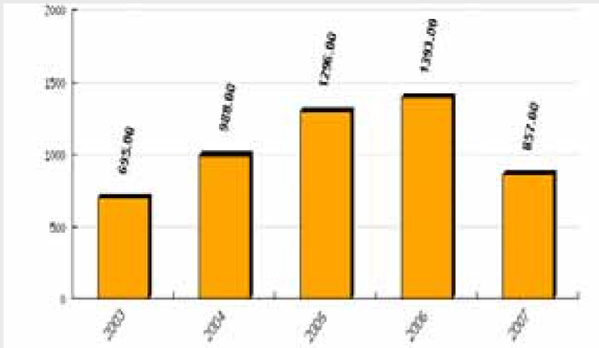
Deviation between calculated and exact U-value for wall-type 1

Model Project 8: Austria (AEA)

n Austria there is already a software tool to collect the information of all leading energy performance certificate programmes in regional data bases (Salzburg, Styria and Carinthia) . Since the good experiences during the DATAMINE project, the Austrian Energy Agency forced to create one national database. So now there are even better conditions for systematic and large-scale approaches to collect and analyse data from energy performance certificates.

During the model project an interface was defined and programmed to transfer the data of the existing data base into the DATAMINE format. Moreover an analysis of more than 7,000 energy performance certificate data sets from the Austrian province Carinthia was carried out. Most of them (more than 5,200) were from new buildings which were erected between 2003 and 2007. So a special emphasis of the analysis was put on new buildings. But there was also a large number of energy certificate data from older buildings (almost 1,500 cases) so that also the existing building stock could be examined.

Fig. 8: Exemplary result from Model Project 8



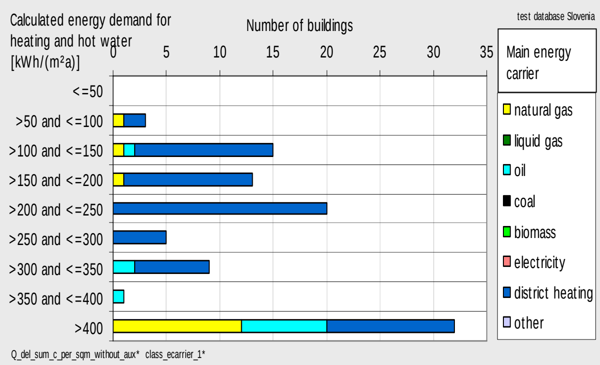
Number of new buildings (“Neubau”)

Model Project 9: Slovenia (ZRMK)

A number of 100 data sets were considered. The analysis was concentrated on big residential buildings which were erected in the 1960s and 1970s and which are now due for modernisation measures. The results show that the energy efficiency of those houses is quite low compared to buildings from other erection periods so that the energy saving potentials should be considerably high.

During the project a data preprocessor software tool was developed which will also in the future make possible the automatic creation of DATAMINE data sets from the existing energy certificate scheme. For the future the chances of an application of the DATAMINE approach in Slovenia are also seen in the quality control of energy certificates.

Fig. 9: Exemplary result from Model Project 9

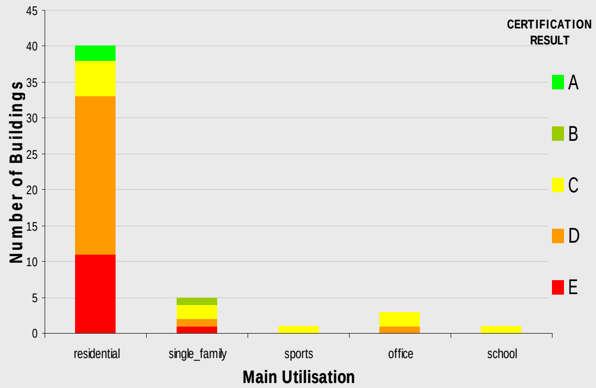


Frequency of calculated energy demand (demand summarized for all energy carriers, per m² reference area)

Model Project 10: Spain (Ecofys)

In the Spanish model project 50 energy certificate data sets, most of them from residential houses, were analysed to obtain an overview of the energy performance of the buildings. In order to prepare future monitoring approaches and make possible the analysis of a larger number of certificates a software tool for the data transfer from the files of a common energy certificate programme to a DATAMINE data base was developed.

Fig. 10: Exemplary result from Model Project 10

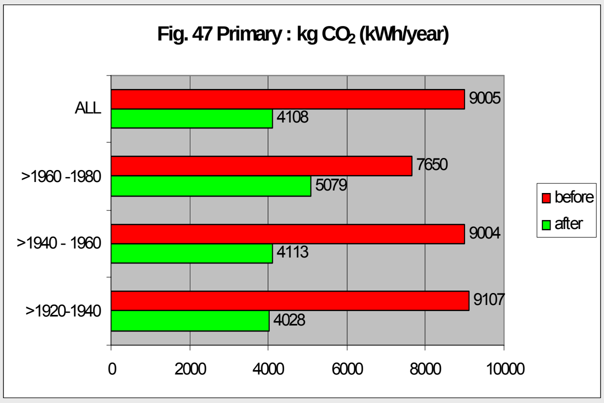


Frequency of energy efficiency class per utilisation type

Model Project 11: Ireland (Energy Action)

There were 126 asset rating data sets of residential buildings available. Besides attaining an overview of the energy performance of the sample a main goal of the project was to compare the “old” Irish energy rating method which was applied in the past with the “new” method according to EPBD which is currently introduced. The results show that altogether there is a reasonably close correlation of the methods and only in the case of the hot water energy values there seem to be considerable deviations.

Fig. 11: Exemplary result from Model Proj. 11

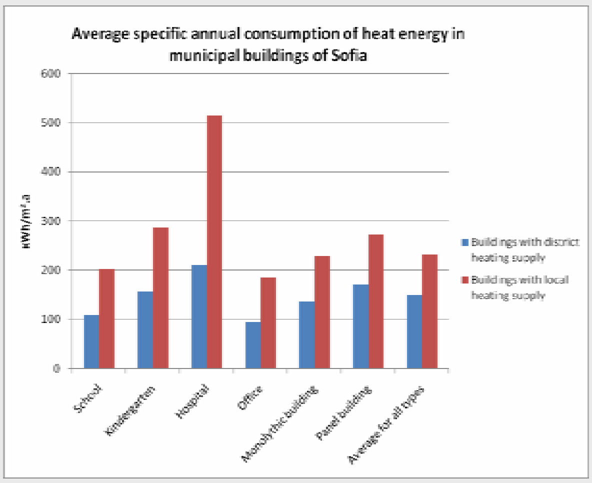


Carbon dioxide emissions before and after refurbishment

Model Project 12: Bulgaria (SOFENA)

The results of operational rating of 493 non-residential buildings were available. Most of them (428) are municipal buildings from Sofia so that the analysis could in the first place deliver a detailed overview of the measured energy performance of the different segments of the capital’s buildings stock (schools, kindergartens, hospitals, administrative buildings).

Fig. 12: Exemplary result from Model Proj.12



Average specific consumption of heat energy in municipal buildings of Sofia

3 The DATAMINE Data Structure

The DATAMINE Data Structure provided a framework for the data to be collected during the monitoring process. A total of 255 parameters were defined of which a suitable sample could be selected to describe the building's energy performance, depending on the concrete case and the type of energy certificate. The following groups of quantities were considered in the Data Structure:

A. Energy Certificate Data

Basic data of the energy certificate, e.g. certification date, classification of the building according to the national indicators which are used in the energy certificates

B. General data of the building

Basic data of the type and size of the building: e.g. location (city), building utilisation, conditioned floor area

C. Building envelope data

Data describing the thermal performance of the building envelope (enclosing the heated part of the building): U-values and area of the elements, window properties

D. System Data

Data describing the building energy supply systems, e.g. type of heat generation systems, type of heat distribution systems, information on air conditioning systems

E. Calc. Energy Demand (Asset Rating)

Quantitative results of asset rating e.g. heat demand, hot water demand, energy input and output of heat generators and air conditioning equipment, boundary conditions of asset rating

F. Basic Parameters of Operational Rating

Information on the basic conditions of operational rating, the outcome (measured energy consumption) is indicated in the following chapter G

G. Summary of Energy Consumption and Energy Generation

Summary of end energy consumption and energy generation, in the first place for operational rating, but also for asset rating.

H. Primary Energy, CO2 Emissions and benchmarks

Primary energy demand and CO_2 emissions for both operational and asset rating

**Fig. 13: Excerpt of the DATAMINE Data Structure:
Data fields No. 91 – 96 out of a total of 255 DATAMINE data fields**

D	System Data					
	heat generation for space heating and hot					
91	degree of centralisation of 1. heat generator	centralisation_heatgen_1		see predefined values. If possible the main system of heat generation in the building (that one which produces the largest amount of heat) should be chosen as first heat generator	p	**dh**: district heating **cb**: central system for the building **ap**: system for each apartment (or for a group of rooms e.g. in office buildings) (in case of one-appartment buildings use cb) **rm**: heat generators in the rooms (e.g. stoves, small electric hot water devices) **other**: other
92	type of 1. heat generator	type_heatgen_1		type of main heating system, see "predefined values". Heat generators of the same type are combined, e.g. if a building is heated by 6 stoves in different rooms they are all united in type_heatgen_1: st (stoves)	p	see "classification lists": heat generator types
93	energy carrier of 1. heat generator	ecarrier_heatgen_1		energy carrier see "predefined values"	p	see sheet "classification lists": energy carrier type
94	use of 1. heat generator	use_heatgen_1		A code indicating the use of the heat generation system (Is the system supplying heat for heating or hot water?). See predefined values. If the heat generator also produces heat (or in case of a "reversible" system even cold) for the air conditioning/cooling system this will be considered below (see quantities assigned to air conditioning)	p	binary code **1. digit**: heating **2. digit**: hot water => 10: only heating, no hot water 11: heating and hot water 01: hot water, not heating
95	erection year/period of 1. heat generator: first year	year_1_heatgen_1	a (year)	Erection year of the heat generator. If it is not exactly known, but the approximate time period is know, insert here the first year of this time intervall (e.g. 1970 if the heat generator was installed some time between 1970 and 1980). If a part of the heat generator was modernised (e.g. boiler installed 1980, new burner installed 1995) insert here the installation year of the main part of the heat generator (in this case: 1980).	f	For example the year 2000 is indicated "2000" (and not: "00")
96	erection year/period of 1. heat generator : last year	year_2_heatgen_1	a (year)	If the installation year is exactly known, insert it here a second time. If only the approximate period is known, insert here the last year of that period (e.g. 1980 for a heat generator that was installed between 1970 and 1980).	f	
97	degree of centralisation of 2. heat generator	centralisation_heatgen_2		similar to 1. heat generator. As far as possible the second largest heat generator (that one which produces the second largest amount of heat) should be considered here.	p	

p: insert predefined values only (e.g. only 5 symbols are allowed for data field No.91: dh, cb, ap, rm or other),
f: free data entry (according to given rules, here for example for the year of erection)

Fig. 14: Example for a DATAMINE classification list (heat generator types / predefined values)

Heat Generator Types	
b	boiler (type unknown)
b_nc	non-condensing boiler (further details unknown)
b_nc_ct	constant temperature non-condensing boiler
b_nc_lt	low temperature non-condensing boiler
b_c	condensing boiler
dh	district heating
el_d	direct electric: any device which uses electricity for direct heat generation, e.g. electric stoves (no heat pumps which use also heat from the environment)
hp	heat pump (type unknown), remark: also reversible engines that work as a cold generator in summer are to be considered here or (if heat source is know
hp_air	heat pump, using the outside air as the heat source
hp_soil	heat pump, using the soil (the ground) as the heat source
hp_exair	heat pump, using exhaust air of a ventilation system as the heat source
hp_water	heat pump, using ground water or a water stream as the heat source
hp_other	heat pump, using more than one or other heat sources (e.g. industrial exhaust heat, low-temperature district heat)
stove	stove (fuel fired, in case of electric stoves use el_d)
chp	cogeneration system: combined heat and (electric) power generation
solar	solar thermal system
steam	steam generator (any type)
other	other
Remark:	
An air/air heat exchanger for heat recovery in a ventilation system is not defined as a heat generator (also not: "ot") but indicated in the ventilation system.	

The Data Structure accounts for different types of energy certificates in the EU countries and in the project partners' Model Projects, as well as the different monitoring aims: For example, the data to be delivered from asset rating (calculation of the energy demand of the building) and from operational rating (measured energy consumption) are very different. The same applies to different types of buildings (certificates of residential and non-residential buildings with or without air-conditioning and lighting).

Against that background the Data Structure neither aims at collecting all available data of a certain type of energy certificates nor will it be necessary (or in many cases even possible) to fill in all of its data fields during a certain application: The basic idea of the Data Structure is to provide a "common language" for the monitoring of energy certificate data: It aims at making possible the documentation of all relevant (not the complete) energy certificate data of a certain monitoring project in a way that it can be clearly understood by others and compared with other projects which are documented in the same way. For this purpose it may be applied on national as well as on international level.

4 Cross-Country Comparison of the Collected Data

During the above described Model Projects more than 19,000 datasets were collected in the 12 different countries. The below shown table (Fig. 15) gives a break down for certificate types, rating types, energy uses, utilisation types and building age classes.

Since the data structure was the same for all databases a comprehensive analysis and cross-country comparison could easily be performed. This was done by use of an MS Excel Workbook, the “DATAMINE Analysis Tool”, which was created during the project.

The following quantities were compared:

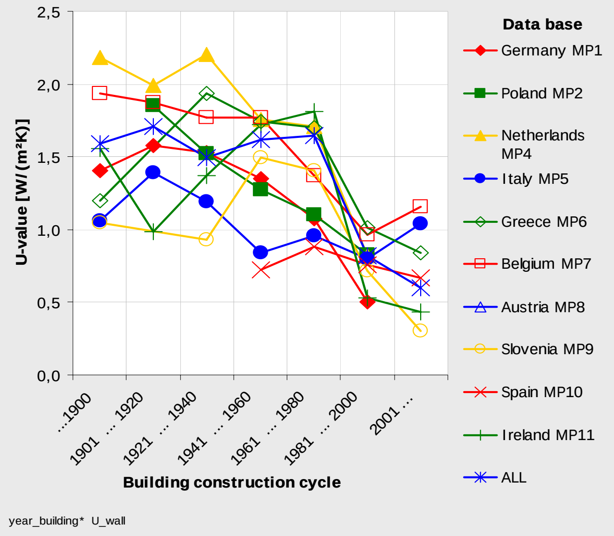
- U-values of walls, windows, roofs and floors: average values for different building age classes (see example in Fig. 16) and frequency distributions;
- envelope areas (specific window, façade, roof and floor areas): frequency distributions;
- calculated heat demand for space heating: average values for different building age classes (see example in Fig. 17), dependence of the thermal transmittance;
- energy carrier types and heat generator types: frequency distributions;
- measured consumption: average values for different utilisation types, correlation with calculated consumption.

Of course, it cannot be assumed that the determined average values are representative for the respective national building stocks. Each Model Project had a different collection scheme and monitoring target, often a certain region was considered, therefore the datasets are more or less a limited case study. The objective of this analysis was not to provide a survey of national building stock properties but to show the benefits resulting from data harmonisation: the possibility of comparing energy-related building data by using a simplified international “language”.

Fig. 15: General statistics of the collected datasets of the 12 Model Projects

Total number of collected datasets			**19095**
Certificate types		**Utilisation types**	
whole buildings	10927	residential buildings	17727
building parts	0	offices	215
apartments	8168	education	612
Rating types		higher education	137
only asset rating	17542	hospitals	68
only operational rating	1112	hotels and restaurants	15
both asset and oper. rating	421	others	378
Considered energy uses		**Buildings constructed ...**	
heating	19053	1900 or earlier	160
hot water	18679	from 1901 to 1940	352
cooling / air conditioning	524	from 1941 to 1980	8616
lighting	10614	from 1981 to 2000	3920
others	10504	since 2001	4313
Contribution of the Model Projects			
MP 1 Germany	515	MP 7 Belgium	113
MP 2 Poland	133	MP 8 Austria	6715
MP 3 United Kingdom	302	MP 9 Slovenia	100
MP 4 The Netherlands	10109	MP 10 Spain	50
MP 5 Italy	188	MP 11 Ireland	126
MP 6 Greece	250	MP 12 Bulgaria	494

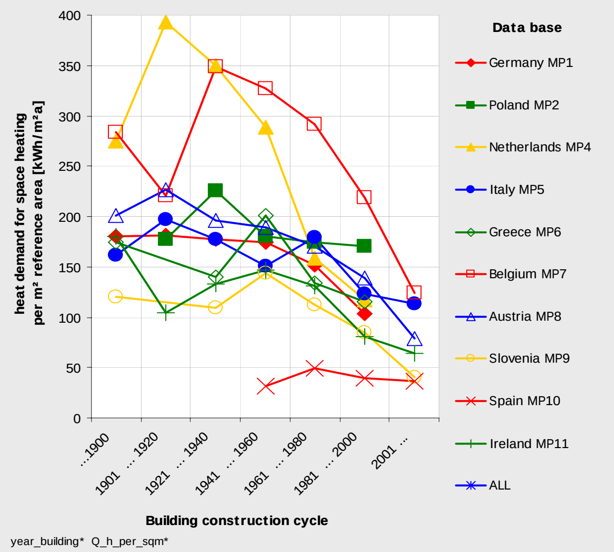
Fig. 16: Cross-country comparison example



U-values of walls – average values depending on building age class

The comparison of average U-values gives an impression of the improvement of the thermal envelope quality during the last 100 years. Whereas the U-values only slightly decreased until the seventies a considerable drop occurs in the last two decades of the 20th century. Comparing the countries a great variety of U-values can be observed for each construction cycle. Of course, these values may not in every case reflect the actual state but also – depending on the certification method – the standard values given by national typologies or by the used EPC software.

Fig. 17: ***Cross-country comparison example***



Calculated heat demand for space heating per m² reference area

In this chart the annual heat need for space heating is shown, which was calculated using the respective national methods. Comparably very high values of more than 300 kWh/(m²a) are found for the databases of the Netherlands and of Belgium. This can be mainly explained by higher U-values. For the other countries a band of 100 to 200 kWh/(m²a) for older buildings is typical (with the exception of Spain, due to different climate conditions). In the case of new buildings the heat demand amounts typically only half of the value of older buildings.

Comparing of Energy Performance Certificate data from different countries: Lessons learnt

An important precondition for comprehensive comparisons like the one used in the analyses mentioned above is that the entire databases are available for all considered countries. Since this may cause problems during future activities (e.g. data privacy) an alternative way for comparison was shown during the evaluation: Subsets of the databases are aggregated in form of building types. Each building type is represented by an “average building”, a dataset determined by averaging the specific envelope areas, the U-values and the energy need for heating. If this aggregation is performed using the same method for each database, cross-country comparisons of the buildings’ energy performance can be performed in a similar way. As a result a simple typology for residential buildings was created for 8 Model Project databases as a showcase for such a procedure.

Apart from comparing the energy-related features of buildings from different countries building typologies can also be used for calculating the energy saving potential for a distinct regional or national building stock (as has been done e.g. in Model Project 1). In consequence one of the conclusions of the DATAMINE project is to set up activities for the design of harmonised National Building Typologies (see chapter 5).

In summary the DATAMINE data structure proved to be a suitable approach for information exchange between countries and for harmonised monitoring activities on EU level. The showcase analysis shows that proper information about trends and characteristics in the building sector can in principle be attained by the proposed indicators and by the data analysis concept.

5 General Experiences and Recommendations

The DATAMINE project is characterised by its bottom-up approach: In the 12 Model Projects a large variety of experiences was made with data collection and analysis. Different types of buildings (residential and non-residential) were analysed using different types of energy certificates and energy audits (asset rating as well as operational rating). Different methods of data collection were applied: Existing databases were used but there was also data transfer from single energy certificates or building energy audit reports – carried out by hand or by a new developed interface for energy certificate software. Also data collection via internet was realised. Even the monitoring aims were very different: Of course, there was always a general motivation to learn more about the energy performance of the building stock, but the specific questions to be answered were very different: For Example, the carbon dioxide savings by refurbishment subsidies of a grant programme were calculated, portfolio analysis of housing companies was supported, energy balance calculation methods were compared.

The variety of conditions and approaches in the 12 Model Projects can be studied in detail in the respective reports (see Overview of DATAMINE reports). However, DATAMINE also intended to make the results comparable and to draw general conclusions. One aspect is the comparability of the different data sets which was made possible by the common Data Structure and which was demonstrated by the cross-country comparison described above. Apart from this remains the basic questions which formed the starting point of DATAMINE: How can we proceed with monitoring the energy performance of the building stock? What can be learned from the DATAMINE project? Which are the next steps?

Certainly we can not give final answers in this complex issue. But on basis of our experiences during the project (also including dissemination activities and the exchange of opinion with representatives of key actors and target groups such as national experts on energy saving and monitoring) we would like to give the following recommendations:

1. Use the DATAMINE Data Structure to make monitoring data bases comparable

The DATAMINE Data Structure has demonstrated its ability to serve as a “common language” that can make data from different projects comparable, also on an international (European) level. So it would surely be useful for the understanding and comparability of monitoring results if this data structure would be more and more used in projects dealing with data collection about the energy performance of buildings. Of course this does not mean that the DATAMINE Data Structure was the one and only concept for systemising the collected data. Such a harmonised structure is necessarily simplified and will not be able to meet the specific needs of every monitoring approach. This was even not the case within the DATAMINE model projects. But a translation will usually be possible: The DATAMINE Data Structure was designed to include the most relevant results of different types of energy certificates issued for different types of buildings in different European countries. Accordingly, what we will usually only need are interfaces which export (“translate”) the existing data to the harmonised structure.

Of course the DATAMINE Data Structure is just a first approach. If it was successfully disseminated in the future, it would certainly be advanced and improved, maybe a bit like a ‘living language’. But care should be taken with creating dialects which might finally result in a ‘Babel of languages’.

2. Use national energy certificate data bases for making statistical analysis

In the course of the implementation of the European directive on the energy performance of buildings (EPBD) some European countries are currently establishing national data bases including information on all officially issued energy certificates. The information is either directly collected via energy certification internet tools or data files that are submitted to the central data base for every certified building by the energy consultants or other persons / institutions who issued the certificate. Certainly this is a very good opportunity to attain statistical information on the national building stock, but this task often appears to play only a minor role during the establishment of these data bases. So it can be recommended to check the opportunities and elaborate concepts for getting statistical information on the building stock by analysing the delivered data. Within this it should be checked if all information that would be valuable is actually collected. Generally it can be expected that energy certificates which are based on asset rating will provide more detailed information than those based on operational rating. Of course here – as in all other monitoring approaches – data protection needs must always be kept in mind and cared for.

National energy certificate databases do not exist in every country but often there are other centralised data collection schemes (e.g. collection of samples of energy certificates, data bases on regional level or in the framework of subsidy programmes) which may as well be used for monitoring purposes.

3. Provide the house owners with the complete information about their buildings

Even if there are no national or other energy certificate databases the chances of using energy certificate data for statistical analysis is not completely lost: If the useful data which are collected and calculated during the making of the certificate are transferred to the house owner they will be available in case of future information demand, e.g. when the house owner is asked to fill in a questionnaire of a large-scale survey for monitoring purposes. But it will also be useful for him when the energy certificate is to be updated or in case that refurbishment measures are planned for the building some years after issuing. The information is not necessarily to be provided as an electronic data file but could also be printed on paper. In this case, of course, not all information should be given directly in the Energy Certificate but in a special appendix with standardised structure.

4. Develop concepts for the monitoring of the national building stocks

The collecting, analysing and comparing of data from energy certificates is not an end in itself. What we really need is better information about the energy performance of the building stock so that we can answer questions like: What are the energy saving potentials in the building stock? How much CO_2 do we save in the building stock every year? Is this sufficient to reach the climate protection goals?

To be more precise we can identify three tasks:

- At first we have to get an idea of the structure of the building stock (which types of buildings are there depending on the year of erection? How are they constructed, e.g. which types of walls were built how often in the respective erection period?).
- Secondly we have to know their current state (How many walls, roofs, heating systems et cetera have already been insulated / modernised in the past?).
- And thirdly we have to know the current trends (How many energy saving measures are carried out every year at the walls, roofs, heating systems et cetera?).

To provide this information is no simple task and it will demand for well-tailored statistical concepts. For example it must be assured that the analysis really leads to representative results for the observed building stock. In the next points 5, 6 and 7 we will examine possible approaches in more detail.

5. Develop building typologies

A first step towards monitoring the energy performance of the building stock is to get a systematic overview of its structure: Different types of buildings were erected in different periods, the used building materials and structures also depend on the size (single or multi-family house) and often on the region. The making of a building typology means to classify the building stock in a systematic way: The typology consists of a set of model buildings with characteristic energy related properties (envelope areas, U-values, supply system efficiencies). Each model building represents a certain construction period and a specific building type and size. The number of buildings or the overall living area per type can usually be derived from national statistics so that with the help of the typology a detailed picture of the building stock can be drawn reflecting the different erection periods. Energy certificate data appear as a well suited information source for the definition of building types for example to identify mean values per building type, e.g. the mean wall area per building or mean U-values of buildings in their original state.

Building typologies already exist in some countries (e.g. in Denmark, the Netherlands, Germany) but even in such cases there might be a need for further development e.g. to define the representative model buildings on a better statistical basis. In other countries building typologies would have to be new developed and here we see good perspectives for harmonised approaches on international / European level: If national and regional typologies were structured in a similar way this would be a good basis for comparison and for getting a detailed overview of the building stock in Europe.

6. Carry out representative surveys

The second and third step of monitoring (quantifying the current state and the current trends of building energy performance) will need special attention and well-tailored methods. For example this task can not automatically be solved by collecting and analysing energy performance data of buildings. It must be assured that the analysis really leads to representative results. This is even the case if national data bases for energy certificate data exist, because as long as there is not an up-to-date energy certificate for every building in the country mean values of the collected data do not necessarily reflect the average state of the whole building stock. So one can expect that energy certificates are often issued for buildings which were recently modernised so that those buildings might be over-represented in the data base[1].

Thus, if there are large energy certificate data bases the question has to be answered, if and how representative results can be attained to certain questions, e.g. by sub-sampling and stratification. Maybe it will turn out that additional surveys are necessary which will anyway be the case if no such national data base exists. Because in the short run not every building will be provided with an energy certificate (and even if: it might not contain all relevant data, see point 3) the certificates hold by the house owners can not serve as the only data source in the survey so that suitable questionnaires might be needed.

7. Monitor the sectors “new buildings” and “rented houses”

Even if apparently not every question can directly be answered by collecting and analysing energy certificate data, there are sub-samples of buildings which are better suited than others: These appear to be the new buildings and the rented houses.

According to EPBD every new building in the EU will be provided with an energy certificate. So here we have a complete covering of the new buildings sector with asset rating data. Collection of this data by central data bases or with the help of representative samples could lead to clear picture of the new buildings sector. Sometimes the new buildings are estimated to be much less relevant for climate protection and energy saving than the existing building stock with its large unused energy saving potentials. But this is not the case if one considers that the existing buildings can not all be modernised overnight. This will take a long time and during this period also the new buildings will accumulate and altogether have a considerable impact to the carbon dioxide emissions. So it will be very important to know how many buildings only keep the national energy saving regulations and how many have a better quality.

As pointed out the analysis of energy certificate data in the existing building stock could be more difficult because energy certificates are not issued for all buildings in the next years. This applies in the first place to owner-occupied houses, mostly single-family houses where energy certificates only need to be issued in case there is a new owner. In the sector of rented buildings the situation is different because the EPBD requires the issuing of certificates in every case of a new rented apartment. So it can be at least assumed that the sector of rented houses (especially larger multi-family houses) will be provided with energy certificates very much quicker than the owner-occupied houses so there might be better conditions for a comprehensive monitoring on basis of energy certificates.

8. Use the opportunity to answer specific questions by monitoring

The previous recommendations concentrated on the monitoring of the complete (e.g. national) building stock. This is of course a central question but there are many others to be faced. The DATAMINE Model Projects showed many exemplary applications of energy certificate monitoring against the background of specific monitoring aims. Here we give some examples of questions which can be answered, there may be others:

- portfolio analysis (e.g. of the building stock of Housing Companies or municipalities);
- monitoring of energy saving support programmes;
- improvement of energy balance methods used for energy certification
  - comparing the calculated energy demand with the measured energy consumption,
  - comparing different methods,

  aiming at an improvement or simplification (and easier application) of the methods;
- quality assurance of energy certificates (applying plausibility tests to the certificates by making use of input and output data, monitoring of energy certificate quality);

[1] In case of deriving basic data about the original state for a building typology this problem has obviously not the same relevance.

Overview of DATAMINE Reports

- **Concepts for Data Collection and Analysis.** First Synthesis Report of the EIE project DATAMINE; Juli 2006

- **Data Collection from Energy Certificates - experiences and analyses.** Second Synthesis Report of the EIE project DATAMINE; March 2008

- **Monitoring by use of Energy Performance Certificates.** Experiences from 12 Model Projects and Conclusions for Energy Performance Monitoring in the European Building Sector; third Synthesis Report of the EIE project DATAMINE; November 2008

- **Model Project Reports**
  - Report Model Project 1 – IWU / Germany (in German + English Summary)
  - Report Model Project 2 – NAPE / Poland (in Polish + English Summary)
  - Report Model Project 3 – ESD / UK (in English)
  - Report Model Project 4 – BuildDesk / The Netherlands (in Dutch + English Summary
  - Report Model Project 5 – DENER / Italy (in Italian + English Summary)
  - Report Model Project 6 – NOA / Greece (in Greek + English Summary)
  - Report Model Project 7 – Vito / Belgium (in Dutch + English Summary)
  - Report Model Project 8 – AEA / Austria (in German + English Summary)
  - Report Model Project 9 – ZRMK / Slovenia (in Slovenian + English Summary)
  - Report Model Project 10 – Ecofys / Spain (in Spanish + English Summary)
  - Report Model Project 11 – Energy Action / Ireland (in English)
  - Report Model Project 12 – SOFENA / Bulgaria (in Bulgarian + English Summary)

All publications are available at the DATAMINE website:
www.meteo.noa.gr/datamine

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